we must look for tests of intellectual efficiency." Not the least interesting paper at the present time is Dr. W. R. Macdonell's note on the result of previous vaccination on the effect of small-pox when incurred. According to the abstract "he shows that the correlation of foveation and size of scar with severity of attack is only moderate, but that there is very considerable correlation indeed in all the recent epidemics, not only between recovery from, but between the severity of the attack and the existence of the scar." It has not hitherto been found possible to obtain statistical data for deducing the correlation between the presence of the scar and the habit of life of the persons attacked. To the miscellanea Mr. Yule contributes a note on local death rates. It is evident from this synopsis that the standard of the publication is being well maintained and that the new biometric methods are capable of extension over the most diverse fields of biological science.

AVIAN ORGANOGENY.[1]

DR. MITCHELL has already devoted considerable attention to the study of the intestinal tract of birds, and in the present contribution he gives us the results of his latest researches, which have embraced all orders of birds and many of the smaller groups.

Adopting the method of investigation pursued by Cuvier, the intestinal tract is removed from the body by severance at the plyorus and the cloaca, and along the mesentery close to the body-wall. Next, the cut ends of the gut are pinned down and its coils unravelled, until they stand revealed as a corrugated tube suspended by the ventral edge of the mesentery.

In tracts so displayed, Dr. Mitchell recognises three distinct loops, a duodenal, a rectal, and a large loop lying between these two which he calls Meckel's tract. The comparison of the varied forms which these loops take constitutes the subject of Dr. Mitchell's researches.

Evolution is rightly the key-note of this work, and accordingly the author starts with a detailed description of what he regards as the most primitive type of gut, from which all others have been derived. This type—found not, as one might have expected, in one of the Ratitæ, but in the ancient goose-like bird, Palamedea—he calls the archecentric type, whilst modified conditions thereof are distinguished as apocentric. Three kinds of apocentricity are recognised—multiradial, uniradial and pseudocentric. Multiradial apocentricities are those which are purely adaptive or homoplastic, and accordingly are of no value as indications of kinship, since they may, and do, occur repeatedly and independently in different groups. Uniradial apocentricities, on the other hand, Dr. Mitchell defines as complex modifications "of a kind that we cannot well expect to be repeated independently, and. . . . must be the most certain guides to affinity."

Not seldom a uniradial apocentricity will form a new centre around which new diverging modifications are produced, and such centres he proposes to call metacentric.

Pseudocentric apocentricity appears to be extremely common and very difficult to distinguish from the archecentric condition. Generally, however, its secondary nature is revealed by some small and apparently meaningless complexity.

The valuation and nomenclature of these characters form a special section of Dr. Mitchell's paper. It is extremely suggestive, and will be read with interest by many who are not directly interested in avian morphology.

The systematic description, which follows this discussion, occupies the bulk of the paper, the intestinal tract of every order of birds being reviewed, copious illustrations serving to bring out, not only the very striking modifications which have taken place, but also the difficulty of the work undertaken.

Space forbids us dwelling, as we would fain do, on this section and the summary thereof at greater length. Suffice it to say that the very remarkable modifications of these loops, which Dr. Mitchell has brought to light, are extremely interesting and very suggestive. We venture to doubt whether a good case has been made out for the position, near the Ralline forms, which has been assigned to the Tinamous. Markedly apocentric though they may be in the matter of their intestinal coils, yet we see no reason why they should not be allowed to remain among or very near the Ratitæ.

The concluding section, on "Characters and Classification," forms a most admirable summary. "In the systematic descriptive part," the author writes, "my task was to treat the characters of the patterns displayed by different birds as nearly as possible as if the gut were the whole animal, and the various phylogenetic figures and the three plates display what I take to be the relations of the intestinal tracts, and not necessarily the relations of the possessors of these tracts. I have been taking, in fact, the anatomical structure as the unit, and not the individual or the species. . . . Granting that the plates attached to this paper represent with approximate accuracy the phylogeny of the intestinal tract in birds, we have yet to learn the relation of the phylogenetic tree of this structure to the phylogenetic trees of other structures, and the relation of all these to the phylogenetic trees of those impermanent combinations of characters which we call species."

We would fain quote more of this interesting section, but enough has, we trust, been set down here to draw the attention of morphologists generally to a contribution which is at once valuable and suggestive, and likely to remain the standard work of reference on this subject for some years to come.

W. P. P.

[1] "On the Intestinal Tract of Birds: with Remarks on the Valuation nd Nomenclature of Zoological Characters." By P. Chalmers Mitchell, M.A., D.Sc. (*Trans.* Linn. Soc., vol. viii. part vii. 1901.)

PHOTOGRAPHY AS APPLIED TO ARCHITECTURAL MEASUREMENT AND SURVEYING.[1]

WHILE the impressions which a photographic picture yields to a casual observer may or may not be correct, the relationship which exists between a photograph and the objects the images of which are depicted is always definite, and a little careful attention in arranging the conditions under which a picture is taken will suffice to make easy the correct interpretation of it.

To understand the geometric nature of a photograph it must be noted and always remembered that for practical purposes a photograph is a surface of two dimensions, which for choice should be a plane surface, and it is only possible to obtain by photography exact copies of similar object surfaces, and these only when the surfaces to be copied are exactly parallel to the picture surface.

Under these conditions written or printed documents or drawings can be, and often are, copied by photography, so as to be practically exact copies of the originals. The copies may be the same size, or larger or smaller, but all proportionate dimensions will be the same, whatever the relative sizes of object and image may be.

To illustrate the first elementary principles of the subject a photographic picture of straight lines and right angles, arranged to form a set of regular squares, was projected on a movable screen. It was shown how, when the screen was parallel to the lantern slide, there was no perceptible bending of the lines and no perceptible enlargement or diminution of any of the angles, from which it might be concluded that there could have been no perceptible distortion in any part of the picture. By moving the screen nearer to, and further from, the lantern, it could be seen that while the forms of the squares remained constant their areas varied with the distance, in obedience to the ordinary laws of rectilinear radiation, from a point, and it was shown how a photographic picture may be legitimately regarded as being made up of a number of points, each one of which is at the picture end of a straight line, which may be taken for practical purposes to have travelled from a corresponding object point through a station point at the apex of a cone of rays radiating towards the picture.

The geometric relationship between distant objects and photographic images of those objects can be most easily appreciated if the lens is supposed to be replaced by a pinhole at the station point, when it is evident that a straight line from any point of the image to the pinhole will, if prolonged, pass through the corresponding object point, and *vice versâ*. Thus any number of true direction lines can be obtained at will.

For making plans, these direction lines can be projected as horizontal rays on a ground plane as in plane table surveying, and positions can be fixed on the plan by the intersection of

[1] Abstract of a paper, by Mr. J. Bridges Lee, read before the Society of Arts on April 16.

such rays from two stations, and checked by rays from photographs taken at a third station when the original intersections are not good or the identification of points doubtful.

When the positions on a ground plan have been fixed and horizontal distances from the different stations have become known, altitudes of points above or below the station can be ascertained by observing the position of the points on the picture and substituting values in a simple formula $h = d \tan \alpha$, where h is the height required, d is distance from the station

FIG. 1.—View from roof of Drummond's Bank overlooking Trafalgar Square.

point for the particular photograph under observation and tan α is $\sqrt{\frac{y^2}{x^2+f^2}}$, where x and y are abscissæ on the principal horizontal and vertical lines as rectangular coordinate axes and f is focal distance for the picture. The practical working of this method of plotting horizontal intersections for obtaining a ground plan and then computing altitudes was illustrated by reference to a series of survey photographs from the south and

FIG. 2.—View from corner of roof of Union Club overlooking Trafalgar Square.

west sides of Trafalgar Square, looking north-east and east, and a plan of the square and neighbourhood on which horizontal traces of the picture planes were drawn. It was explained how in practice the horizontal distances of points from the principal vertical line of a photograph are first set off on narrow strips of paper, which are then transferred to the picture traces on the plan and direction lines set off from the station points through the selected points on the strips, when in all cases the direction lines would pass through the corresponding points on the ground plan of Trafalgar Square and the visible region round. It was also explained how to compute the height of St. Martin's Church from the pictures.

Two of the pictures used for illustration are here reproduced. It will be seen that these pictures bear some markings on their faces which are not usually found on ordinary photographic pictures.

(1) The horizontal line right across the picture is the horizon line, which marks the trace of the horizon plane of the lens (or station). It contains the principal axis of the lens.

(2) The vertical line is the trace of the principal vertical plane, which also contains the principal axis of the lens and the station point.

(3) The intersection of (1) and (2) is the centre or principal point of the picture perspective.

(4) The scale at the top is part of a compass scale, and serves to show the magnetic orientation of the principal axis of the view, the vertical line serving as index.

(5) The scale immediately below, which stretches as a band across the picture, is a scale of reduced horizontal angles (a tangent scale to a great circle of a sphere of radius equal to the exact working focal length).

The MS. notes in the corners are memoranda originally noted on slips of celluloid by the photographer and put in place in special carriers before each picture was taken. All these markings were printed as latent images at the same time exactly and by the same exposure as the picture.

It was explained how all these markings were accurately obtained by aid of a simple mechanism specially designed by the author, who is responsible for introducing the system of recording automatically on the picture face information necessary for interpreting the picture, and how by aid of this information practical photo-surveying, which used to be often difficult, has become very easy and much more certain and accurate than formerly. The apparatus specially designed by the author and used for obtaining these pictures was shown and explained in some detail.

The lecturer concluded by expressing a hope that in due time a simple standard type of working camera, fitted with a good lens and accurate recording mechanism (which could be easily removed and replaced at will), would find its way into general favour, and that regular libraries of standard readable pictures of interesting objects would come into existence.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speeches delivered by Prof. Love in presenting Dr. W. H. M. Christie, C.B., F.R.S., Astronomer Royal, and Dr. A. W. Rücker, F.R.S., Principal of the University of London, for the Degrees of D.Sc. *honoris causa*, at the Encænia, on June 24.

Inter mathematicos, qui Cantabrigiæ quattuor et triginta abhinc annos graduati sunt, clarum erat nomen Willelmi Henrici Mahoney Christie, nunc inter omnes omnium gentium astronomos clarissimum. Astronomorum profecto ille annus magno proventu floruit cum in eodem Tripode Georgii Darwin nomen contineatur. Ambo hi viri Collegii Sanctæ Trinitatis socii creati sunt, sed in astrorum scientia alter alteram insistebat viam. Ille solis stellarumque soli parentium ultimam vetustatem investigabat: hic noster se negotio utiliori dedit ut solis stellarum siderumque omnium et locos qui nunc sunt et motus accuratissime notaret. In hoc opere tantam peritiam adeptus est ut iam viginti abhinc annos et Astronomus Regius et Societatis Regalis Sodalis crearetur. Hoc gubernante fere omnia in Observatorio Regio maximo vel novata vel in melius mutata: neque enim id solum curavit ut novis instrumentis cederent vetera, sed ut eadem paullo immutata idonea fierent ad sidera observanda observationesque ita factas memoriæ tradendas quemadmodum iubent astronomi recentiores. Ita vir peritissimus et rem felicissime navavit et ærario publico pepercit. Summa eius in rem publicam merita agnovit Regina nostra Victoria quæ eum titulo Comitis de Balneo ornavit: insigni honore prosecutæ sunt Academiæ Parisensis Petropolitana aliæque complures quæ eum inter externos litterarum commercio sibi adiunctos receperunt. Huius nomine inter Doctores nostros inscripto monstrabit profecto Academia nostra se